Government of Canada / Gouvernement du Canada

ACTION REQUEST / **FICHE DE SERVICE**

TO — *À*: B. TAYLOR

FILE NO. — *DOSSIER N°*:

DATE: OCT 29/79

FROM — *DE*: C. KLAPONSKI

	TEL. NO. — *N° DE TEL.*	EXT. — *POSTE*
☐ PLEASE CALL *PRIÈRE D'APPELER*		
☐ WANTS TO SEE YOU *DÉSIRE VOUS VOIR* ☐ WILL CALL AGAIN *DOIT RAPPELER*	DATE	TIME — *HEURE*
CALL RECEIVED BY *MESSAGE REÇU PAR* ▶		

☐ ACTION *DONNER SUITE*
☐ COMMENTS *COMMENTAIRES*
☐ MAKE *FAIRE_____ COPIES*
☐ APPROVAL *APPROBATION*
☐ DRAFT REPLY *PROJET DE RÉPONSE*
☐ SIGNATURE
☐ NOTE & RETURN *NOTER ET RETOURNER*
☐ NOTE & FORWARD *NOTER ET FAIRE SUIVRE*
☐ NOTE & FILE *NOTER ET CLASSER*

MAP ENCLOSED. TRACKS AGREE WITH MIKE NEWARK'S ASSESSMENT - IN PARTICULAR THE TRACK FROM MICKSON TO BRIGHT WAS CAREFULLY CHECKED AND CONFIRMED.

C.K

Was map with hydro outages marked

eye witness account of tornado birth N of Woodstock

No more damage after end of 2nd track as shown. They flew length of track & down to Lake Erie

? a mile? searched for damage

do they have radar pictures showing 2 separate tornado cells

no looks

the flew over next day — Mike flew over day of storm & also did ground survey track Hickson to Bright is continuous

General Descriptions of Damage

Between approximately 6:30 and 7:30 p.m. EDT August 7, 1979, tornadoes devastated part of southern Woodstock and communities in the vicinity of this southwestern Ontario city. Destruction was immense. Two fatalities occurred, and about 150 were injured, 8 seriously (A.E.S., 1979). More than 1,000 people were left homeless in and around the communities of Hickson, Bright, Woodstock, Oxford Centre, Norwich, Vanessa, New Durham and Waterford. In a 15-block area of southwestern Woodstock, 75 homes were destroyed and 250 heavily damaged, as well as 8 factories (Toronto Star, August 8, 1979). At Oxford Centre, a village of 200 located six kilometres southeast of Woodstock, almost every building was destroyed, including thirty homes, the general store, two churches and the 100-year old community centre (L.F.P., 1979). "Trees 0.5 to 0.6 metre in diameter were snapped off approximately 1.8 metres above ground". (A.E.S., 1979). Approximately half of the 55 homes in Vanessa, another village about 30 kilometres further southeast, were destroyed (L.F.P., 1979). "Damage to 28 felled transmission towers of the Ontario Hydro was estimated at 3 million dollars". (A.E.S., 1979). These towers are generally built to withstand winds of 160 kilometres per hour (100 mph), according to an Ontario Hydro officer (The Toronto Sun, August 8, 1979). A great many farms - some more than 100 years old - were destroyed or heavily damaged. "Many livestock were killed and crops damaged in the area". (A.E.S., 1979). Damage estimates for property, excluding crops, have ranged into the tens of millions of dollars, even going as high as 100 million dollars (L.F.P., 1979;Brampton Daily Times, August 8, 1979).

Characteristics of the Tornadoes
As reported in Climatic Perspectives (A.E.S., 1979):

"That morning, tornado touchdowns were reported at Powassan, south of North Bay. During mid-day funnel clouds were also confirmed over Lake Ontario, near Oakville, with another reported at Toronto International Airport. This activity occurred along a warm front which extended southeast from Sault Ste. Marie.

"A cold front extending southwestward from central Ontario set off the severe thunderstorm and tornado activity over the southwestern part of the province early that evening. There appeared to be three separate storm tracks."

The details of the tornado tracks will be discussed in a forthcoming report from the Ontario Weather Centre. The longest track (which extended through Oxford Centre) was about 32 kilometres, with almost complete destruction occurring in a path width varying from 0.4 to 0.8 kilometre. (A.E.S., 1979). The width of a tornado path also includes those peripheral areas which received only "minor roof damage (shingles removed), some glass breakage, damage to fences, carports and awnings, some tree damage (limb breakage) and damage to commercial signs (large billboards)." (Minor et al., 1977). These relatively minor types of damage are usually caused by 120 kilometre per hour (75 mph) winds. Using this criterion, the path width through Oxford Centre was about 1.0 kilometre. Thus, the Pearson-scale path length (P_L) is P3 and the Pearson-scale path width (P_W) is P4 (see Table 1).

TABLE 1
The Fujita-Pearson (FPP) Tornado Scale

Maximum windspeed		Path length		Path width	
F 0	less than 73 mph	P 0	less than 1.0 mile	P 0	less than 18 yd
F 1	73-112	P 1	1.0-3.1	P 1	18-55
F 2	113-157	P 2	3.2-9.9	P 2	56-175
F 3	158-206	P 3	10-31	P 3	176-556
F 4	207-260	P 4	32-99	P 4	0.3-0.9 mile
F 5	261-318	P 5	100-315	P 5	1.0-3.1

Source: Fujita (1973)

Minor et al. (1977) state that an assessment of housing damage can provide general estimates of tornadic windspeeds in the lower windspeed ranges (below 240 kilometres per hour or 150 mph), and a coarse distinction between moderate and severe winds can be obtained for higher windspeed ranges. However, they warn that such estimates are reliable indicators of tornadic windspeeds only if the housing is of a general quality which is typical of cities with building codes and a strong codes enforcement program. In particular, they state that rural housing is a very poor indicator of tornadic windspeeds due to generally inferior construction practices. Based on their extensive work in this field, Minor et al. (1977) have found that construction practice is the most significant factor that influences the resistance of a house to tornadic

winds. Other factors which determine the windspeed at which a structure is damaged or destroyed are: house orientation, house geometry, shielding of houses, terrain features and tornado-generated missiles.

Given the number and variety of buildings destroyed or damaged during the tornado outbreak of August 7, we feel that a general estimate of the maximum windspeeds can be determined from building damages throughout the area. By comparing the pictures and descriptions of the types of damage which occur at various windspeed ranges, as given in Minor et al. (1977) and Fujita (1973), to pictures taken by us and others, we estimate a maximum windspeed range of 250 to 275 kilometres per hour (155 to 170 mph). This range corresponds to the lower end of Fujita-scale windspeed F3 (see Table 1) and windspeed ranges (4) to (5) of Minor et al. (1977), as given in Table 2. Although much damage in the Woodstock area appears to correspond to F-scale 4 (windspeeds of 207 to 260 mph), the better constructed residences in the same areas are not damaged to this degree. Therefore, we based our windspeed estimate on these latter structures, keeping in mind that most building damage is actually caused by winds in the 120 to 200 kilometre per hour (75 to 125 mph) range i.e. buildings generally fail at relatively low windspeeds (Minor et al., 1977). Table 3 is a brief summary of the general characteristics of the tornadoes which devastated the Woodstock area on August 7:

TABLE 3

Maximum windspeed	Path length	Path width
F 3 250-275 k/h (155-170 mph)	P 3 16-50 km (10-31 miles)	P 4 .5 - 1.5 km (.3 - .9 mile)

The translational speed of the tornadoes was approximately 75 kilometres per hour (45 mph). This was determined by Ontario Hydro, based on the times of successive power outages along the tornado's path. Thus, the rotational wind velocity of the tornadoes was approximately 175 to 200 kilometres per hour (110 to 125 mph). This estimate is consistent with the rotational speed reported in the Toronto Star of August 8 (the source of the value quoted in the Star is not given). An eyewitness account of the rotational direction of the tornado-generating cloud near Woodstock (L.F.P., 1979) reveals that it was turning cyclonically (ie.

TABLE 2

TORNADO DAMAGE TO RESIDENCES

Windspeed Range	Damage Description	Windspeed Range (mph)	Equivalent F-scale
(1)	TV antennae bent; a few roof shingles blown off; light weight awnings and canopies damaged.	40-75 (18-34 m/s)	F0
(2)	Windows broken by flying debris; large sections of shingles removed from roof corners and eaves; residential chimneys collapsed.	75-110 (34-49 m/s)	F1
(3)	Sections of roofs and porches damaged, especially if inadequately anchored; large sections of gabled roofs may be torn off on leeward side; carport roofs lifted; extensive damage to garage roofs, if door is on windward side.	110-130 (49-58 m/s)	F2
(4)	Entire roofs removed and carried away by the wind, leaving first floor walls standing; roof removed from two story houses, some second story exterior walls collapsed. Roofs undamaged only if extraordinary anchorage precautions have been taken, such as the use of hurricane clips.	130-160 (58-72 m/s)	F2-F3
(5)	Two-story residences almost completely destroyed; exterior walls on single story dwellings collapsed with only well supported interior walls standing.	160-200 (72-89 m/s)	F3
(6)	Little remains intact; debris scattered down path of the tornado.	>200 (>89 m/s)	F4

Source: Minor et al. (1977)

in a clockwise direction as seen from below). The great majority of tornadoes rotate in this direction.

Calculations of Tornadic Windspeeds

It is also possible, through the windspeed analysis procedures discussed in Minor et al. (1977), to estimate the threshold windspeed value required to cause a given structure to fail. We performed a calculation of the threshold windspeed required to aerodynamically lift a truck and house trailer combination, which was overturned and smashed into a row of large trees planted along the driveway in which it had been parked at the time of the tornado passage through Oxford Centre. This calculation is based on a similar one performed by Minor et al. (1977). Credence levels for this calculation are questionable in one component (definition of strcutural system) because the degree of complexity of the truck-trailer system necessitates simplifying assumptions in the calculations.

The uplift pressure necessary to equalize the weight of the truck-trailer system (9550 lbs) is:

$$p = 9550 \text{ lbs} / 396.6 \text{ sq. ft.} = 24.08 \text{ psf}$$

Since $p = 0.00256 C_p V^2$

where C_p is the uplift pressure coefficient = 0.7 on a flat roof

Therefore

$$V = \sqrt{\frac{p}{(0.00256)(0.7)}}$$

$$= 115.9 \text{ mph } (185 \text{ k/h}).$$

This is the threshold windspeed required to lift the truck-trailer combination, assuming the roof of the system is flat and that winds cannot pass underneath the structure.

Tornado-Generated Missiles

The Oxford Centre area was littered with missiles of various sizes and weights. Straw missiles were everywhere due to failure of a large barn upwind

of the village. Straw was found embedded about ½ inch into the fissured bark of large hard-wood trees (maple and poplar). Actual penetration into the wood was not observed in these trees.

The types of missiles noted in the Oxford Centre area were determined by the material that was available in the path of the tornado. The tornado had struck the village from the northwest, across fairly open fields. When it impinged on the nearby farm and village, it quickly picked up and projected objects of various sizes and weights. Pieces of wood from roofs and walls of destroyed houses and tree branches were common missiles in Oxford Centre and elsewhere. Most of these objects, once windborne, appear to have flown for hundreds of metres. Gouge marks were left by debris in the grass of small open fields in the village and in the Cemetery, and also in an asphalt paved surface. Metal siding material from barns and silos was observed bent and twisted around trees and other objects. The material originated in the farm about 0.4 to 0.8 kilometre upwind of the residences in the village.

In one house on the left side of the damage path, a tree branch about 6 centimetres in diameter, a plank about 30 centimetres wide and 2.5 centimetres thick, and a smaller piece of wood were driven into the stucco and wood frame wall at the rear of the house. Other examples of this phenomenon also occurred. In one case, sited by the London Free Press (1979), a two-by-eight plank (5 cm by 20 cm) crashed through a livingroom window and pierced the wall of a New Durham home. Another case sited by the Toronto Star (August 8) involved a two-by-four (5 cm by 10 cm) which flew through a hallway, smashed through one wall of the kitchen and imbedded itself in another wall just above the kitchen sink. Countless examples of holes left in windows, walls, roofs and cars, plus impact marks on brick and stucco were evidences of the quantity and sizes of flying debris. Some trees were partially debarked by flying debris.

Most of the automobiles in Oxford Centre were either destroyed when trees fell on them or when they were blown from their parking places. At least two cars had still not been located the afternoon after the storm. They had presumably tumbled at least a mile into the valley to the southeast. One automobile had been moved about 100 metres through a row of trees into the next yard. A truck in Oxford Centre was also tossed about 100 metres (Toronto Star, August 8). A farmer north of Oxford Centre reported that his camping trailer had been

blown nearly a kilometre down the road (L.F.P., 1979). In one case in Oxford Centre, a skidoo had been moved into the next-door neighbour's yard. A car was swept from an adjacent lot into the basement of what had been a New Durham house and another car was blown and tumbled about 400 metres into a field (L.F.P., 1979). Other examples of cars, trucks and vans which were blown and tumbled are shown in the London Free Press report (1979).

Summary

In less than one hour on the evening of August 7, 1979, a family of three tornadoes killed two people and severely damaged a number of communities and surrounding areas near Woodstock in southwestern Ontario. The Fujita-Pearson FPP scale for maximum windspeed, path length and path width is estimated as F3, $P_L 3$, $P_W 4$ (Table 3).

Many tornado-generated missiles were evident during the storm, ranging from field straw to house trailers. Much damage was done to buildings, trees and machinery from impact and penetration by airborne missiles.

References

Atmospheric Environment Service, 1979: Climatic Perspectives, Vol. 1, No. 27, August 17, 1979.

Eagleman, J.R., V.U. Muirhead and N. Willems, 1975: Thunderstorms, Tornadoes, and Building Damage. Lexington Books, Mass.

Fujita, T.T., 1973: Tornadoes Around the World. Weatherwise, Vol. 26, No. 2, 56-62, 78-83.

London Free Press, 1979: Tornado. London Free Press Printing Company Limited, London, Ont.

Mehta, K.C., J.E. Minor and J.R. McDonald, 1976: Windspeed Analyses of April 3-4, 1974 Tornadoes. Journal of the Structural Division, ASCE, 102, ST9, Proc. Paper 12429, 1709-1724.

Minor, J.E., J.R. McDonald and K.C. Mehta, 1977: The Tornado: An Engineering-Oriented Perspective . NOAA Technical Memorandum ERL NSSL-82.

Texas Tech University, 1979: Tornadic Loads for Design and Evaluation of Structures. Institute for Disaster Research, Texas Tech. University, Lubbock, Texas. (Lecture notes for a short course presented by J.R. McDonald, K.C. Mehta, J.E. Minor and R.F. Abbey, Jr.)